Docket 6739

In the United States Patent and Trademark Office

Express Mail mailing label number EL 501537995 US

Date of Deposit January 11, 2001

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SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

I, John G. Spakousky, a Citizen of the United States and a resident of Minneapolis, Minnesota, have invented certain new and useful improvements in a

Composite Building Block With Modular Connective Structure

of which the following is a specification.

PRIORITY

This application is a continuation-in-part of U.S. Patent Application Serial Number 09/390,435 filed September 7, 1999, entitled "Composite Building Block With Connective Structure," which is a continuation-in-part of U.S. Application Serial No. 08/795,691, now Patent Number 5,983,585.

FIELD OF THE INVENTION

This invention relates to building blocks. More particularly, the invention relates to composite building blocks made with a modular connective structure and prefabricated walls constructed using the blocks.

BACKGROUND

Building blocks have developed over time. Originally, solid bricks were used. These evolved into cinder blocks. These blocks are formed of concrete and have a pair of holes formed through the blocks. A typical cinder block is shown in Figure 1 of U.S. Patent No. 1,567,430 to Eberling. Another type of cinder block is shown in Figure 1 of U.S. Patent No. 2,172,052 to Robbins. The holes in the cinder blocks make the blocks considerably lighter, can be used as a space within the blocks to receive and hold reinforcing bars, and can be filled with concrete once the blocks are placed. The webs separating holes can be used to form a handle to help carry and position the blocks.

The basic cinder block has changed little over time. However, new blocks have been developed to make construction more flexible. For example, in U.S. Patent No. 4,982,544 to Smith, a precast concrete module for use in constructing load-bearing retaining walls is disclosed. The walls in Smith are capable of supporting large vertical loads. The Smith precast concrete modules comprise a plurality of face walls and integrally formed connecting walls configured to form cavities in the modules.

When the Smith precast concrete modules are assembled into a load-bearing wall, concrete may be poured into each cavity to finally form the load-bearing wall.

A number of blocks were developed to provide better insulation. A normal cinder block that is filled with cement has no space for insulating material. Although the blocks do provide some insulating properties, such blocks are best known as heat absorbers. Thus, a block wall absorbs heat in the summer and holds that heat, which causes an increased cooling load. Conversely, in winter, they "absorb cold" (lose heat internal to a building), increasing the heating load. To solve this problem, several blocks have been developed to allow for insulative material to be placed within the blocks, thereby breaking the thermal flow paths. Examples of these blocks are found in the following U.S. Patents. U.S. Patent No. 3,593,480 teaches a block that has an outer appearance that is similar to an ordinary cinder block. The block is actually a plastic shell containing cavities that are filled with concrete. The block also has open areas that can be either dead air space or can be filled with insulating material. The problem with these blocks is that they must be filled with concrete, and the concrete must be cured, before they can be set into place. Once filled, these blocks become heavy and are difficult to work with.

U.S. Patent No. 4,380,887 to Lee teaches a cinder block that is made with special slots that allow foam insulation to be inserted into the slots. The idea is to break up the thermal conductivity through the block webs. Although this design is an improvement, it still requires a full size block, with all the weight problems associated with that. Moreover, the insulating panels are designed to be inserted from both the top and the bottom of the block. Inserting the panels slows down the

construction process if the blocks are insulated in the field; if the insulation is added at the factory it adds to the cost of the construction of the blocks.

U.S. Patent No. 4,498,266 to Perreton teaches a cinder block that has a center channel to hold blocks of insulation. U.S. Patent No. 4,745,720 to Taylor teaches a cinder block that is cut in two lengthwise. The split block is then reassembled with a special insulating channel in the center. Special clips are provided to secure the insulation within the block. U.S. Patent Nos. 5,209,037 and 5,321,926 teach cinder blocks that have complex curves formed in them to receive insulation. Although these blocks provide improved insulating capabilities, the complex curved design increases cost and provides minimal hand holds for block placement. This makes construction more difficult and slow, which also increases cost.

U.S. Patent No. 4,841,707 to Nova teaches an alternative direction in block wall construction. As noted above, one problem with ordinary concrete or cinder blocks is the transmission of heat through the blocks themselves, i.e., their poor insulating qualities. The blocks above seek to break the transmission path. Another way to do this is to use a double wall. Such a wall has the outward appearance of an ordinary block wall, but has an outer block wall and an inner block wall that are connected by bracing. The space between the walls can be filled with insulating material to provide improved levels of insulation. The problem with the Nova wall is that there are no discrete blocks. Both walls are poured. Although this is an acceptable building method, it can be expensive, especially for residential type construction.

In U.S. Patent No. 4,180,956 to Gross, there is disclosed a cavity wall structure comprising hollow panel units interconnected by ties, and enclosing insulating elements. The Gross wall structure,

however, appears to have limited applicability in the construction of load-bearing walls. Gross Fig. 1 shows wall panel units that are much thinner than its depicted insulating elements. The Gross wall panel units thus appear unsuited for supporting heavy loads. Because of their relative thinness, it is not clear how they would conform to conventional U.S. building code structural requirements. Furthermore, components of the Gross wall structure are interconnected with ties located at panel unit edges that not only tie together opposed inner and outer walls, but link adjacent panel unit edges. This makes the Gross wall system inapplicable in wall construction projects where construction personnel are trained in building walls by laying discrete blocks with mortar interconnections. A person building one of Gross' walls would need to deal with several separate panel units and ties that would have to be assembled at the same time as the stacking of the insulating elements. It is not clear that one person working alone could easily perform this assembly.

U.S. Patent No. 5,709,061 shows a sandwich construction unit that utilizes a structural connector to make a composite concrete masonry cavity wall. The structural connector is shown as applicable for both floor to ceiling wall panels (Fig. 1) and masonry block wall construction (Figs. 8-10). In either application, the structural connector extends the entire distance between the floor and the ceiling. In the masonry brick application, the connector is placed between the vertically adjacent edges of two horizontally-adjacent blocks. Thus, the connector is not used to form single discrete blocks, but rather is used only when blocks are stacked to build a wall. It appears that each block would be threaded onto the connector as the wall is built. However, it is also possible that the connector could be threaded down through several stacked blocks.

An improved modular building block for load-bearing wall construction is needed. In addition, a need exists for lighter modular blocks that have low thermal conductivity and retain a high load bearing capacity. Furthermore, a need exists for structures that employ modular building blocks for the creation of improved structural panels. Finally, additions that add stability and that may be integrated into a wall constructed using modular blocks are also needed.

SUMMARY

The present invention involves a discrete composite block construction. The inner and outer walls of the composite block may be separately formed. At least one of the inner and outer walls may be cement, clay brick, stone or other masonry type material having a good vertical load-bearing capacity.

Connected to the at least one wall and extending between the inner and outer walls is a connective structure. This connective structure comprises multiple separate components and is made of plastic and/or other formable material that can be readily formed into thinner and more complexly shaped structures than cement, clay brick, stone or other masonry materials, due to its flowability characteristics during forming and its greater tensile and/or shear strength after forming. These qualities of the material used in the connective structure, as well as its shape and configuration, permit a variety of advantages to be achieved in block wall construction. The inner and outer walls are joined with the connective structure to form a discrete, composite modular block before the block is placed in a wall.

One embodiment of this invention is a discrete, preassembled, composite modular block, comprising a outer wall and a inner wall, at least one of which is load-bearing and made from a first

material. The composite modular block further comprises a connective structure formed of a second material different from the first material, and connected between the inner and outer walls, said connective structure comprising two or more connective struts, each extending between and connected to both the inner and outer walls, such that the inner and outer walls are securely positioned with respect to one another as opposite faces of a discrete rectangular block.

Another embodiment of the present invention is a load-bearing wall comprising a outer wall and a inner wall, at least one of which is load-bearing, with the outer wall and the inner wall connected by a connective structure formed of a different material than the walls, said connective structure formed of at least two elements, one being a separate panel member placed between the outer wall and the inner wall, the panel member extending in a plane parallel to the inner and outer walls and being connected in cooperative relationship with at least one connective strut.

Yet another embodiment comprises a load-bearing wall made from discrete composite blocks, each including a outer wall and a inner wall, at least one of which is load bearing. The outer wall and the inner wall of each block are connected by a connective structure formed of a material different than the wall material. The discrete individual blocks are combined to form the wall with at least one reinforcement or tension member connected within the load bearing wall to provide interblock strength.

Yet another embodiment of the present invention includes a method for the formation of a preassembled wall block unit, the method comprising providing a inner wall having at least one receptor; providing a outer wall having at least one receptor; providing two or more connective struts, each having a wall connector on each end of the connective strut; matingly engaging the inner wall receptor with one of each connective strut's wall connectors; and matingly engaging the outer wall

receptor with one of each connective strut's other wall connector, such that the inner and outer walls are securely attached to one another and such that a least one cavity is formed between the inner and outer walls.

Yet another embodiment of the present invention includes a panel member for insertion into a connective structure in a composite block to extend between and partition the space between an inner wall and an outer wall of the block.

One or more of the following advantages can be achieved with the present invention; a building block that is lightweight and easy to install in the field; a building block system that has full structural integrity and yet can be well insulated; a building block system for use in the construction of load-bearing walls; and a building block system where composite blocks may be easily configured for the requirements of a particular building project.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of an embodiment of the composite block of the present invention.

Figure 2 is a top view of a wall structure using an embodiment of the present invention.

Figure 3 is a perspective view of an embodiment of a connective structure of the present invention.

Figure 4 is a perspective view of an end connective strut of an embodiment of the present invention.

Figure 5 is a perspective view of a center connective strut of an embodiment of the present invention.

Figure 6 is a perspective view of the main portion of a panel member used in an embodiment of the present invention.

Figure 7a is a side view of the secondary portion of the panel member of Figure 6.

Figure 7b is a front view of the secondary portion of the panel member of Figure 6.

Figure 8 is a perspective view of the secondary portion of the panel member of Figure 6.

Figure 9 is a top view of an alternative embodiment composite block of the present invention for corners.

Figure 10 is a top view of a corner construction made with the composite blocks of Figure 9.

Figure 11 is a top view of an alternative embodiment block of the present invention.

Figure 12 is a top view of an alternative embodiment block of the present invention with insulation material inserted in the connective structure.

Figure 13 is an end view of the alternative embodiment block of Figure12 with insulation material inserted in the connective structure.

Figure 14 is pictorial view of an embodiment of the block of the present invention with an inserted insulation panel member.

Figure 15 is a pictorial view of the connective structure with inserted insulation panel member of Figure 14 with block walls removed.

Figure 16 is a top view of an alternative embodiment composite block of the present invention with a closed-off end.

Figure 17 is a front view of a wall according to the present invention with tension members inserted therein.

Figure 18 is a top view of the wall of Figure 17 with tension members inserted therein.

Figure 19 is a front view of a wall of the present invention with reinforcement bar inserted therein.

Figure 20 is a top view of the wall of Figure 19 with reinforcement bar inserted therein.

Figure 21 is a perspective view of a wall made of the present invention with a ladder reinforcement material inserted therein.

Figure 22 is a side view of a wall made of the present invention with a ladder reinforcement material inserted therein.

Figure 23 is a front view of a wall according to the present invention with transverse panels inserted between the inner and outer walls.

Figure 24 is a top view of the wall of Figure 23 with transverse panels inserted and a column formed between the panels.

Figure 25 is a perspective view of a retaining wall made using composite blocks in accordance with the present invention.

DETAILED DESCRIPTION

A. General Description

The present invention involves improvements on the composite blocks with connective structures and on walls made from such blocks, both as shown in U.S. Patent No. 5,983,585. The connective structures described in the '585 patent incorporate a planar center portion. While such connective structures are suitable for some applications, they have certain disadvantages. First, the connective structures themselves occupy a relatively large volume when shipped, because the planar

center portion with its arms traverses much of the volume between inner and outer walls. Second, such a large connective structure may be damaged by rough handling before its incorporation in a block. Third, the extent and location of the arms and the planar center portion may make it difficult to place rebar or other reinforcing elements, to thread conduit or other materials inside the walls, and may also make it more complicated to pour concrete effectively inside constructed walls.

Accordingly, the present invention involves improved designs for connective structures and blocks using the connective structures that address these disadvantages. It also shows wall panels that are preferably made with blocks having the connective structures. In one embodiment, the present invention forms its connective structure from a plurality of discrete components or modules. The fundamental components of the connective structures are connective struts. Many of the same benefits associated with the prior connective structures are found with the present embodiment. The composite block of the present invention has the strength of a conventional cinder or concrete block, i.e., it has load-bearing properties that are characteristic of a conventional cinder or concrete block, but with less weight. The discrete components or modules comprising a connective structure may weigh less in the aggregate than the prior art connective structures but still provide substantially the same structural stability as prior blocks and a wall formed utilizing the same. Because of the thermal characteristics of these connective structures, when a wall is finished using these composite blocks, it may have the insulation characteristics of a true double wall construction. The composite blocks may incorporate optional, separate panel members and be used in a wall filled with concrete on one side of the optional panel members and filled with insulation on the other side. Alternatively, the panel members may themselves comprise a layer of insulation. This provides a structurally sound wall that is well insulated.

The composite blocks can be full height or half height size and also may come in corner configurations. These composite blocks, when used in walls, may further be strengthened with tension members, reinforcement bars, internal columns, etc. that are further discussed herein. Moreover, the present connective structures may still provide a handle to permit easy handling and placement of the composite blocks.

Referring now to Figure 1, a perspective view of one embodiment of the present invention is shown. The composite block 50 has an outer wall 52, an inner wall 54, and a center connective structure 56 made from several discrete components or modules. The outer wall 52 and the inner wall 54 can be made from cement, clay brick or similar materials. Other suitable materials are natural or man-made including, plastic, wood and ceramic materials. The outer wall 52 and the inner wall 54 of the present embodiment may have identical forms, although this is not required. In alternative embodiments discussed below, the outer wall 52 and the inner wall 54 may be comprised of different materials in the same composite block 50.

1. The Connective Structure

As shown in Figure 1, the connective structure 56 of the present embodiment further comprises a first end connective strut 58, a second end connective strut 60, and a center connective strut 62. The connective struts 58, 60, and 62 are discrete elements that, when connected to and between the walls 52, 54 collectively form the connective structure 56 that rigidly secures the outer wall 52 to the inner wall 54. As Figure 1 shows, the central connective strut 62 may be larger and stronger than the first end connective strut 58 or second end connective strut 60, although those reasonably skilled in the art

will appreciate that this design may be varied (e.g., with the end struts equal in strength but stronger than the center strut or with two identical end struts only) without changing the nature or scope of the present invention.

The outer wall 52 and inner wall 54 may further comprise a number of dovetail-shaped grooves 72 that extend vertically (in the block's usual orientation). These grooves 72 receive and hold the separate strut components of connective structure 56. In the embodiment shown, the connective struts 58, 60, and 62 have wall connectors at their ends that may be friction fitted into a groove 72 of the outer wall 52 and the inner wall 54. In the present embodiment outer wall 52 and inner wall 54 each utilize three dovetail-shape grooves 72 extending between the upper and lower edges of the inner and outer walls, one groove to receive each of the connective struts 58, 60, and 62. The dimensions of the grooves 72, in addition to their number, may be increased or decreased by those reasonably skilled in the art, depending on the size and number of connective struts 58, 60, and 62 that are desired for a given application. In addition, the location of the grooves may be varied, with the end grooves being closer or farther from the wall edges, and the orientation of grooves need not be vertical. The grooves may be at an angle other than ninety degrees relative to the top and bottom edges of the walls 52, 54.

In the embodiments shown in Figures 1-3, the center connective strut 62 may be used as a handle for the modular block 50. The center connective strut 62 may have surfaces or edges that are flush with the top surface of the outer wall 52 and inner wall 54. These surfaces or edges may be flat or otherwise adapted to allow a worker to easily pick up and place the composite block 50 by gripping the center connective strut 62. The present embodiment composite block can be easily handled by one

person, a significant advantage when persons trained in conventional masonry build a wall from the composite blocks 50.

As illustrated in Figure 5, the center connective strut 62 of the present invention may further comprise a first end 64, a second end 66, a first insert-type wall connector 68, and a second insert-type wall connector 70. The insert-type wall connector 68 and insert-type wall connector 70 may be affixed to or formed at a corresponding end of the connective strut 62 such that the insert-type connector 68 and insert-type connector 70 can be fixedly connected to a wall receptor, such as the dovetail-shaped grooves 72 of the outer wall 52 and inner wall 54. The present embodiment utilizes friction fitting to fixedly engage the insert-type connectors 68 and 70 in the grooves 72; however, other wall connectors known to those reasonably skilled in the art may be substituted in alternative embodiments. To provide stability, it is desirable that each wall connector 68, 70 be somewhat elongated and that its longitudinal extent (i.e., its length in the direction of its corresponding receptor groove) be at least one-sixth and preferably about one-fourth or one-third of the length of the corresponding receptor groove.

The first insert-type connector 68 of the present embodiment may be further comprised of a first leg 74a, a second leg 74b, and a plate 75. The first leg 74a and the second leg 74b may be fixedly connected to the plate 75, forming a v-shaped structure. The second insert-type connector 70 of the present embodiment may further comprise a first leg 76a, a second leg 76b, and a plate 77. The first leg 76a and the second leg 76b may be fixedly connected to the plate 77 forming a V-shaped structure as shown in Figure 5. The V-shaped insert-type connectors 68 and 70 are designed so that they may be frictionally engaged into one of the grooves 72 of the outer wall 52 or the inner wall 54. The plates

75 and 77 provide a connection between the insert-type connectors and the rest of the connector 62, in addition to providing further structural integrity to the connector 62.

In order to improve the security of the friction fitting, each leg 74a, 74b, 76a, and 76b may have compression-limiting projections 78 extending into the V-shaped structure formed by a leg pair. The projections 78 further secure the center connective strut 62 in the dovetail groove 72 by making it very difficult to press together the legs of the V-shaped connectors (beyond the point at which the opposed projections 78 would collide). The projections 78 thus make it harder for the insert-type wall connectors 68 and 70 to deform, and thus for the whole connector 62 to pull free of the groove 72 and the corresponding wall of a composite block 50.

The center connective strut 62 of the present embodiment may be further comprised of three rectangular members 80, 82, and 86. The rectangular members 80, 82, and 86 are edge-connected lengthwise (preferably by integral forming) to form an open-top channel or box structure that makes up the central portion of the connective strut 62, stretching from the first end 64 to the second end 66. Forming these rectangular members 80, 82, and 86 into a channel or box structure may provide the center connective strut 62 with improved structural stability against twisting. Furthermore, rectangular strut 86 may be formed with a shape that contains formed recesses, cutouts or openings (shown at 162 and in phantom at 163) for allowing the insertion and guiding of rebar, tension wires, and other types of insertions into the cavity between the outer wall 52 and the inner wall 54 of the composite block 50 (see discussion below).

As illustrated in Figure 4, the first end connective strut 58 and second end connective strut 60 of the present invention will be further described. In the present embodiment the first end connective

strut 58 and second end connective strut 60 are substantially similar and will be described in terms of the end connective strut 58. The end connective strut 58 may be further comprised of a first end 84, a second end 86, a first insert-type wall connector 88, and a second insert-type wall connector 90. Each of the insert-type wall connector 88 and insert-type connector 90 are affixed to a corresponding end of the connective strut 58 such that the insert-type connector 88 and insert-type connector 90 can by insertion be fixedly connected in a dovetail-shaped groove (receptor) 72 at each of the outer wall 52 or the inner wall 54.

The first insert-type wall connector 88 of the present embodiment may be comprised of a first leg 92a, a second leg 92b, and a plate 95. The first leg 92a and the second leg 92b may be fixedly connected to the plate 95, forming a V-shaped structure. The second insert-type wall connector 90 of the present embodiment may have a first leg 96a and a second leg 96b, which may be formed into a V-shaped structure extending from a plate 97. The V-shaped insert-type connectors 98 and 90 are designed so that they may be friction fitted into one of the receptor grooves 72 of the outer wall 52 or the inner wall 54. In further embodiments where the outer wall 52 or the inner wall 54 is made out of alternative materials, other types of connections may be substituted by those reasonably skilled in the art. As with the wall connectors 68, 70 on the center connective strut, each leg 92a, 92b, 96a, 96b is somewhat elongated and its longitudinal extent (i.e., its length in the direction of its corresponding receptor groove) is at least one-sixth and preferably about one-fourth or one-third of the length of the corresponding receptor groove.

In order to improve the binding of the friction fitting, each leg 92a, 92b, 96a, and 96b may have a number of rib formations 98 situated on the outer surface of the legs. The rib formations 98 further

improve holding of the end connective strut 58 in a dovetail groove 72, making it harder for the insert-type connectors 88 and 90, and thus the whole connective strut 58, to pull free of the groove 72 and the corresponding wall of the modular block 50.

The end connective strut 58 of the present embodiment may be further comprised of two substantially planar, rectangular members 100 and 102. The rectangular members 100 and 102 are edge-connected lengthwise (preferably by integral forming) substantially at a right angle. Thus, they may form a member with an L-shaped (or T-shaped) cross-section that makes up the central portion of the connective strut 58. Forming the rectangular members 100 and 102 into an L-shaped or T-shaped cross-section beam provides the end connective strut 58 with improved structural stability against twisting, and therefore provides stability and rigidity to the modular block 50 as a whole.

In the present embodiments, the connective struts 58, 60, and 62 may be made of high strength plastic, ABS plastic, polyethylene, rigid polymers, fiberglass, or other composites. Furthermore, the connective struts may be formed of a moldable plastic surrounding a stronger reinforcement material, such as a steel rod, carbon fiber, or similar materials.

It should be noted that as shown in Figure 1, the end connective struts 58, 60 are positioned at one end of their corresponding receptor grooves 72, while the center connective strut 62 is positioned at the opposite end of its corresponding groove 72. In addition, the grooves 72 for the end connectors 58, 60 are located relatively near and parallel to the outer side edges of the walls 52, 54. This permits connection of the connective struts 58, 60, 62 at three relatively widely spaced points on each of the walls 52, 54. This positioning, together with the resistance of the connective struts 58, 60, 62 to twisting and flexing and the strength of the elongated wall connectors helps ensure that the connective

structure as a whole provides structural integrity to the entire block, i.e., that the outer wall and the inner wall are securely positioned with respect to one another as opposite faces of a discrete rectangular block.

2. Panel Member Additions to Connective Structure

The connective struts 58, 60, 62 can be combined with separate panel member components to provide connective structures with additional features. As shown in Figures 1-3, a separate cavity partitioning panel 130 can be received on the connective struts 58, 60, 62 to extend parallel to the walls 52, 54. As best seen in Figures 3, 6, 7a, 7b, and 8, the panel member 130 may comprise a main portion as shown in Figure 6, to which is linked an insert or secondary portion 132 (Figures 7a, 7b, 8). These are joined by snaps 133a, 133b that fit in openings 131a, 131b. Mating member or projection 133c on insert or secondary portion 132 fits into a selected one of holes 133d (Figure 3) in strut 62. The main and secondary portions together form a partitioning panel member that, as further explained below, can partition a wall constructed of individual blocks 50 (each having a panel 130 aligned with adjacent panels 130) into a first and a second internal cavity. In addition to its partitioning role, the separate panel member 130 can, after its insertion, help provide additional strength to the connective structure 56 based on the discrete connective struts 58, 60, 62 to which the separate panel member is joined.

Somewhat similar to the partitioning panel 130 is another form of separate panel member that may be added to and supported on the connective structure. Figures 12 and 13 show an insulating panel 222. Such a panel 222 is made from a block of insulating material formed with one or more

recesses to receive the connective structure 210. While a primary purpose of such a panel member 222 is to add insulation value to a wall, it can also provide partitioning of the internal wall space to make a concrete-receiving cavity. In addition, with more rigid insulating materials, the panel 222 can help provide additional strength to the connective structure to which it is joined. Further, by use of a connective structure 210 that has a member extending longitudinally adjacent one wall, the connective structure 210 cooperates with the insulating panel 222 to form a "weep" gap or cavity between the panel member and the adjacent wall.

Figures 14 and 15 show a further alternative embodiment of a composite block with an insulation panel. Here, again, a separate insulation panel member 330 is installed between the outer wall 352 and inner wall 354 so as to provide a "weep" gap or cavity 360 between the panel member 330 and the outer wall 352. Spacers 340 are used to establish the gap or cavity 360. As best seen in Figure 15, the insulation panel member 330 has multiple spacers 340 affixed to its surface facing the outer wall 352 and recesses that permit the panel member 330 to be inserted around the connective structure 356. If desired, the panel member 330 can be made from an upper segment 330a and a lower segment 330b that are joined after their insertion. However, with appropriate coordination of the connective structure 356 and the recesses in panel member 330, the panel member 330 can be made in one piece, inserted at an angle and rotated to its final position between the struts of the connective structure 356.

The panel member 330 can be made of compressed polystyrene beads, or extruded polystyrene, polyisocyanurate, polyurethane or other suitable formable insulation. The spacers 340 can be made of any suitable formable plastic. Both the panel member 330 and the spacers 340 must have

adequate strength to resist the pressure of wet concrete that may be poured into the cavity between the panel member 330 and the inner wall 354. The weep gap or cavity 360 spanned by the spacers 340 not only allows water that penetrates into this gap or cavity to collect and flow down to weep holes (not shown) near the lower edge of a wall made of composite blocks but also allows upward convection flow of hot air in a wall made of composite blocks that absorbs significant solar heat and may be equipped with vents (not shown) near its upper edges.

As alternative to the separate spacers 340, the panel member 330 can be made with integral protrusions or ridges (similar to corrugations) that abut the adjacent outer wall 352 to form the weep cavity 360. A further alternative is to form the inner surface of the outer wall with integral protrusions or ridges that abut the panel member 330 to form the weep cavity 360.

3. Advantages and Alternatives

In the present embodiment, the material comprising connective struts 58, 60, and 62 will be lighter in weight than most conventional, non-composite block material. Lightweight connector materials allow for the building of lighter weight composite blocks. Lighter composite blocks may be cheaper and easier to transport and utilize at the construction site. In other embodiments requiring greater structural support, the connective struts could be made of alternative materials which may be heavier in weight. The connective struts 58, 60, and 62 may also be substantially thermally inert (i.e., substantially non heat-conductive), although this is not a requirement and, in some embodiments (e.g., blocks for internal walls), may be unnecessary. For example, in applications where additional resistance to deformation or fire strength is more important than insulating value, the components of connective

structure 56 may be made of metal or metal alloys, even though the thermal characteristics of many metals are such that significant heat energy may flow through them.

Alternative embodiment construction materials have a number of significant implications for the composite blocks and the walls formed with them. Alternative construction materials may be desired for the inner and outer walls 52, 54, depending on the load bearing requirements of the wall constructed with the material. Alternatively, variations in wall material may impart other desired characteristics, such as low acoustic transference, lighter weight, etc. The designer of a composite block is not limited by the possibilities offered by traditional masonry type materials, as there is no need to form the walls and the connective structure from the same materials.

The connective struts 58, 60, 62 provide advantages to the present invention composite block 50. The separate center connective strut 62 and separate pair of end connective struts, 58, 60 can be shipped in less volume than a connective structure that incorporates a planar central portion. The connective struts 58, 60, 62, once installed in a block, occupy a relatively small volume compared to the overall volume within the modular block 50 and have a relatively low weight. Furthermore, because the connective struts are small, they do not require a large amount of material to make, and yet provide a significant amount of structural stability to the composite block 50. In addition, the light weight of the connective structures means that the modular block 50 may be easy to transport and to install with masonry techniques. Walls made out of the present invention composite blocks may be of equal strength, both in support and in resistance to shear forces, as walls made with heavier, conventional blocks. The connective structure formed of individual, separate connective struts and/or panels, and the wall connectors themselves, contribute to the above-described strength of the wall. The insertion of

the wall connectors in the receptor grooves of the outer wall 52 and the inner wall 54 of the composite block allows for the quick and easy assembly of the modular blocks 50.

The outer wall 52 and inner wall 54 of the modular block 50 may be formed utilizing the same equipment used to form concrete blocks, but using a different mold insert. Because the outer wall 52 and inner wall 54 may be made without molding an interconnecting structure at the same time, a greater number of blocks can be created in one mold cycle than if a traditional full concrete block were being formed. This permits improved utilization of the block-forming equipment and associated labor. For example, it has been found that a mold forming wall pieces may produce, in one mold cycle, twice the number of pairs (inner and outer walls) of wall pieces as the number of blocks that would be produced in the prior art mold cycle.

The outer wall 52 and the inner wall 54 do not need to be constructed of the same material. For example, a modular block could be formed with a outer wall of brick and a inner wall of concrete, or vice versa. The inner and outer walls of blocks may be made with different colors or one or both may be subjected to different, additional processes after forming. For example, a brick wall piece may undergo a glazing process after forming to provide a glazed brick surface for the outer or inner wall. Or a stone or other veneer could be adhered to a concrete outer or inner wall. Thus, either the inner or outer walls can be formed first as a substrate, with other surface treatments to be applied as desired.

The connective struts 58, 60, 62 as shown in Figure 1 are positioned such that the center strut 62 is near one edge of walls 52, 54 (upper edge in Figure 1), while the end struts 58, 60 are near the opposite edge (lower edge in Figure 1). While this provides a broad, three point connection at each of the walls 52, 54, the struts 58, 60, 62 could be displaced inward from these edges. For example, all

three struts 58, 60, 62 could be aligned in one horizontal plane, if all were inserted the same distance from one edge of the walls 52, 54. By moving the grooves 72, varying the insertion distance of each strut 58, 60, 62 in each groove 72, or placing a strut at each of the top and bottom of one groove 72, a variety of different connective structures 56 can be configured with the same struts. That is, the same set of connective struts may be selectively positioned in different configurations in inner and outer walls having the same groove configuration. If the block and wall designer has the additional freedom to determine where the grooves are placed in the inner and outer walls, then further additional configurations for the connective structure are possible with the same set of connective struts.

B. Walls Constructed With Modular Block 50

Walls constructed with modular block 50 as described above, may be constructed at the site in which they are to be used, or alternatively, may be prefabricated off-site at a plant or an assembly area. Another advantage to the relatively light weight of the present invention modular block 50 is that a relatively large prefabricated wall may be constructed and easily transported for utilization at the construction site. Discussed below are several different embodiments and variations of walls constructed with the modular blocks 50 of the present invention.

The connective structures shown above assist in the fabrication and ultimate strength of the prefabricated walls. Prefabricated block walls usually require some sort of structural enhancement in order to be lifted, moved and placed after they are fabricated. Mortar joints alone between individual blocks 50 are normally insufficient. Although joints can be formed with other adhesive agents, e.g., epoxy mixes, latex polymers, glue, these are generally also insufficient. The large amount of between-wall space left open by connective struts 58, 60 and 62 permits the placement of a variety of structural

enhancements in a variety of locations and positions. In addition, as noted previously, the connective struts 58, 60 and 62 can include recesses, openings or other formations to support and /or guide the structural enhancements. Finally, the flexibility to provide connective struts in a variety of positions (by placement of grooves 72 and selective insertion of struts to varying depths in these grooves) permits there to be coordinated design of the prefabricated walls, with the structural enhancements and connective struts cooperating not only in their placement so as to accommodate each other, but in their contributions to the strength of the prefabricated wall.

There are several aspects of this embodiment of the connective strut 56 for wall construction. It can be seen from Figures 1 and 5 that the center connective strut 62 has several recesses 162, although more or less than the two recesses shown in Figure 1 may be used. These recesses 162 may be used as horizontal retaining support for structural enhancement (not shown in Figure 5), such as tension members or reinforcement bars, when the connective strut 56 of a modular block 50 is adjacent to one or more other connective structures in a wall. It can also be understood that the center connector 62 may be placed at the upper or lower edges of the block walls or inserted to a selected vertical depth away from an edge. The wall designer can thus vary the vertical displacement of the center connector 62 with respect to the end connectors 58 and 60. This displacement may make placement of rebar in the recesses relatively easier and may add to the structural integrity of the wall.

Referring now to Figure 2, details of a typical wall assembly 110 constructed according to the present invention are shown. Figure 2 is a top view of a section of wall assembly 110 formed by the modular blocks 50 of the embodiment of Figure 1. The wall assembly 110 may further comprise an outer wall 112, an inner wall 114, and a cavity 116 therebetween. The adjacent modular blocks 50

may be placed as shown. Mortar 120 may be applied between the modular blocks 50 of the outer wall 112 and the inner wall 114 to form a joint between the modular blocks 50 as shown. The outer wall 112 and the inner wall 114 of the present embodiment are substantially parallel. The cavity 116 formed in the interior between the outer wall 112 and the inner wall 114 contains the connective struts 58, 60, 62, but is largely open space. This interior may be utilized as a space to place electrical wires, water, and HVAC conduits, filled with insulation or concrete, etc. Figure 2 shows that a partitioning panel member 130 may be inserted between the walls 112, 114 of a block 150 to partition the cavity 116 into a first cavity 134 and a second cavity 136 (see also Figure 1). The utility of having two separate cavities is discussed above. The further utility of the prefabricated walls arises from the fact that typically the structural enhancements added within the wall are embedded in concrete. This can be done by placing these structural enhancements with surrounding concrete in either of the two cavities 134 or 136, leaving the other available for insulation or other uses.

1. The Cavity Partitioning Panels

As shown in Figures 1, 3, and 6, the connective structure 56 of the wall formed utilizing the present invention may be adapted to fixedly receive a panel member 130. The main portion of panel 130 of the present embodiment is illustrated in Figure 6 and may be fixedly inserted as shown in Figure 3. The holes 131a and 131b shown in Figure 6 (which are used with a sealing insert 132 described below) may be situated on opposite sides of a cut-away section of panel 130. The cut-away section is so that the panel 130 may be fitted over the center connector 62. Furthermore, two notches 135a and 135b may be adapted to receive the end connective struts 58 and 60. See Figure 3. The panel 130

may be of a size to span a full vertical cross-section of the cavity 116 between and substantially parallel to the outer wall 112 and the inner wall 114.

The panel 130 may further comprise two snap-receiving holes 131a and 131b. The panel 130 may further comprise an insert 132 or secondary portion. This insert 132 of the present embodiment may fill in the cut-away that is formed in the panel 130 that allows for the panel to be placed over the center connective strut 62 of the modular block 50. The insert is illustrated in Figures 7a, 7b, and 8. The insert 132 may further comprise two snaps 133a and 133b and projection 133c. The snaps 133a and 133b enable the insert 132 to be fixedly connected to the panel 130 by coupling to the holes 131a and 131b, respectively. Projection 133c is inserted into one of holes 133d in connective strut 62. The insert 132 overlaps the panel 130 enough so that a seal is created between the panel 130 and the insert 132. The seal is sufficient to prevent flow of concrete, insulation or other material from one side of the panel 130 to the other.

As shown in Figure 1, inserting a panel 130 between the walls of composite block 50 creates a first cavity 134 and a second cavity 136 between the outer wall 52 and the inner wall 54. The first cavity 134 of the present embodiment, as shown in Figure 1, is larger than the second cavity 136. In alternative embodiments the first cavity 134 and the second cavity 136 may be any size relative to one another. In fact, by making panel 130 an optional, separate component of the connective structure 56, and forming multiple holes 133d in connective strut 62, the placement of panel 130 becomes a variable design choice. This eliminates the need for multiple versions of an integral connective structure, each having a different placement of its cavity partitioning panel.

When a wall is formed with the composite block 50, whether as a prefabricated unit or on site, the overlapping panels 130 and inserts 132 of adjacent composite blocks 50 may form a relatively complete seal between the first cavity 134 and the second cavity 136 of adjacent blocks 50. The addition and placement of these panels 130 and inserts 132 may be done when connective struts are inserted; alternatively, these may be inserted around connective struts already present in a composite block 50 quickly and easily by an individual as the walls are formed. The seal created by the insertion of the panel 130 and the insert 132 between the inner and outer walls of each modular block 50 may allow for the placement of concrete, insulation, or other materials into one of the first cavity 134 or the second cavity 136 for structural or insulation purposes.

2. Tension Members as Structural Enhancements

The alternative embodiment of a wall formed from discrete blocks 50 depicted in Figures 17 and 18 may further comprise a tension system. The tension system may further comprise one or more tendons 250, at least one upper anchor member 254, and at least one lower anchor member 252. The tension system may be incorporated into a wall formed with mortar or may be used in a mortarless dry stack system. The tension system may provide further structural support for the wall formed from the modular block 50. The upper anchor member 254 may be connected at a upper end of the wall. The lower anchor member 252 of the present embodiment may be at or near the bottom of the wall. The tendons 250 may be fixedly attached at each end to the upper anchor member 254 and the lower anchor member 252. The amount of tension that the tendons 250, and thus the wall, is be subjected to may be determined by one skilled in the art depending on the material used to form the blocks 50 and the required strength for the wall. The tendons 250 may be placed on either side of any partition

formed by optional partitioning panel members 130 or insulation panel members 330, i.e., on a side where concrete may or may not be poured, but they are preferably encased in concrete.

As will be appreciated by one skilled in the art, the tendons 250 may be wires, cables, or other structures known to those reasonably skilled in the art. The lower and upper anchor members 252 and 254 may be plates, bolts, U-bolts, or any other anchor member known to those reasonably skilled in the art. The tension system may be an enhancement to a wall constructed of the composite block 50. The tension system may allow for greater versatility in construction techniques when using the present invention to form a prefabricated wall, or a wall at the construction site. The wall may incorporate multiple tendons 250 that are placed between various levels of the wall formed, so that there is an overlapping series of tendons 250 between the top and bottom of the wall. Furthermore, the tendons 250 may also be connected by using the connective structures of various modular blocks 50 as the anchor members when these connective structures are connected to the block walls in truncated receptor grooves or other receptors that would prevent any migration of the connective structures in the grooves when subject to tension.

One advantage to the tension system may be the ability to create a prefabricated mortarless drystack system. Mortar requires skill and experience to lay down in a consistent manner. Utilizing the dual wall modular block 50 of the present invention with the tension system may facilitate the easy and cheap construction of a high strength prefabricated, mortarless wall using the present invention modular, composite blocks 50.

3. Reinforcement Bars as Structural Enhancements

As illustrated in Figures 19 and 20, reinforcement bars 256 may also be placed between the outer wall 112 and the inner wall 114 of an alternative embodiment wall. Reinforcement bars 256, or rebar 256, are well known to those reasonably skilled in the art for the reinforcement of structures made with concrete and other building materials. Because of the relatively small amount of space the connective struts 58, 60, and 62 take up between the inner and outer walls, ample room may be left for the placement of the rebar 256 in several different configurations. The rebar 256 may be placed in a vertical manner, running from the upper end of a wall unit to the lower end, or may also be placed in a horizontal manner running parallel to the outer wall 112 and the inner wall 114, or may be further placed in an X-shaped pattern in a plane parallel to the walls 112 and 114. The recesses and openings 162, 163 of the center connective strut 62 may provide a guide to the placement of the reinforcement bars 256 when they are placed in certain configurations. Alternatively, grids (not shown) with a variety of openings for rebar may be snapped on to selected connective struts 58, 60, 62 to produce aligned supports for rebar. As will be appreciated by those reasonably skilled in the art, different patterns for rebar 256 may impart different structural characteristics to the wall they are reinforcing. Furthermore, the cavity in which the rebar 256 is placed may be further filled in with concrete, foam insulation, or other encasing materials as is desired by the user.

As illustrated in Figures 17 and 18, yet another embodiment of the wall unit constructed of the present invention modular block 50 may incorporate both the tension system and rebar members 256 described above. A wall incorporating these characteristics may be a prefabricated construction or built into position. The tendons 250 and rebar 256 may be placed in any manner discussed above to

impart the desired structural characteristics upon the wall unit the user desires. Thus, horizontal rebar 256 may be placed at the top of block courses, with the tendons 250 extending vertically.

As seen in Figures 23 and 24, an embodiment that permits encasing of tendons 250 or rebar 256 in concrete without filling the entire internal wall cavity with concrete involves use of one or more transverse partitioning panels 260 inserted parallel to the connective struts and extending vertically from the top to the bottom of the entire wall. When such transverse partitioning panels are present, they permit forming an internal vertical column 270 of concrete. The connective struts in the stacked blocks can both guide and support the vertical transverse partitioning panels 260.

4. Ladder Reinforcement Material

As illustrated in Figures 21 and 22, a further embodiment of a wall of the made from the composite blocks 50 may further comprise a ladder reinforcement material 262. As illustrated in Figure 21 and 22, the ladder reinforcement material 262 may be operably positioned and fixed between layers or courses of the composite blocks 50 (note that the connective structure 56 is for clarity omitted in Figures 21 and 22). As will be appreciated by one skilled in the art, the reinforcement material 262 may be fixedly attached in the mortar 120 of one embodiment, and/or encased in concrete filing a cavity 134, 136 formed by optional partitioning panels 130 (shown only in phantom).

As illustrated in Figure 21, the ladder reinforcement material 262 of the present embodiment may be comprised of a two parallel side pieces 264 and a plurality of parallel transverse rungs 266. The parallel transverse rungs 266 are fixedly connected between the parallel side pieces 264. As will be appreciated by those skilled in the art, the rungs 266 may be placed in other parallel or non-parallel patterns. The side pieces 264 and the rungs 266 may be made of a steel rod, or other materials known

to those reasonably skilled in the art. The rungs 266 may also be shortened so that the ladder reinforcement material 262 extends only from the mortar 120 of one wall 112 or 114 out to an internal cavity filled with concrete.

The ladder reinforcement material 262 of the present embodiment may be utilized in a wall constructed of the composite block 50 to provide further reinforcement to the wall. For example, if the wall undergoes a severe fire, and the connective structure 56 is made out of a plastic whose heat resistance is exceeded, the plastic might melt, leaving the outer wall 52 and the inner wall 54 standing without a connective structure binding the outer wall 52 and the inner wall 54 of the modular block 50. The reinforcement material 262 may provide some additional connective security in such a situation.

When a wall is prefabricated before transportation to the construction site using any of the above materials, including panels 130, tendons 250, rebar 260, or ladder reinforcement materials 262, the wall should be constructed in such a size that can be transported and utilized at the construction site. The present invention modular blocks 50 are of relatively light weight, allowing for the creation of prefabricated walls of relatively large size without creating unusual transportation and utilization issues.

5. Dissimilar Wall Materials

While at least one of the outer wall 52 and inner wall 54 is load-bearing, it is not necessary that the remaining wall be load-bearing. This is particularly the case for interior walls, where loads may be lighter. This opens up additional possibilities for the materials and finishes used. In a non-load bearing wall, the wall can include pre-formed apertures or other features that may be part of a wall design. For example, the outer wall 52 or the inner wall 54 can be formed with an aperture for receiving an electrical connector, a pipe, or other electrical or mechanical elements needed in construction. A inner

wall can alternatively be formed with airflow apertures that can be used for an HVAC system that delivers air through conduits in the wall. The connective strutures shown herein allow ample room for internal structures.

6. Retaining Wall Applications

Blocks and walls according to the present invention are also suitable for use in certain retaining wall applications. As best seen in Figure 25, a retaining wall 400 may be formed from a plurality of discrete blocks 450 placed on a footing 402 located at the bottom of the retaining wall 400. The individual inner walls of blocks 450 form an inner wall 454 that faces the earth mass to be retained, while the individual outer walls 452 of the blocks 450 will be visible as the outer face of the retaining wall 400. The blocks 450 may be laid with mortar in the usual manner as for a wall bearing vertical loads or they may be stepped back in the manner often used for higher retaining walls.

A frequent issue for effective retaining walls is how to avoid excessive build-up of hydrostatic pressure in the earth or other mass retained by the wall. This problem can be addressed effectively with the block structure of the present invention. The connective structures 456 can be formed with a partition panel 430 that permits the space between the inner walls 454 and the outer walls 452 to be partitioned into a first cavity 462 that may filled with concrete to make the final wall 400 a more unitary structure. For extra strength the concrete-filled cavity 462 can also be reinforced with rebar, taking advantage of the large amount of space for rebar afforded by the connective structures 456 of the present invention. In addition, the second cavity 460 on the other side of the partition panel 430 is available as a weep cavity for draining water from the retained mass. Water in the retained earth mass can be facilitated to enter the weep cavity by apertures in the inner walls 454. These may be formed by

placing orifices in the mortar joints 404. The orifices can be formed by tubes or channels 410 that are part of the connective structure 456 or attached to it and that extend through the mortar joint and over the edge of the inner wall to which a connective structure 456 is attached. The water entering at these orifices flows down into the weep cavity 460 and can be channeled to exit out the front or an end of the wall 400 in any suitable manner.

A retaining wall that is higher and/or that must resist greater lateral loads may be supported by a deadman 470 placed in the earth mass to be retained and tied to the wall 400 by a tie 472. Here again the present invention can provided a benefit. The connective structure 456 can be formed with a tie connection 412 extending out at a mortar joint 404 and receiving one end of the tie 472. The other end is attached at the dead man 470. Such ties 412 can be placed at any desired interval by using a connective structure 456 that includes one or that has one attached to it.

C. Alternative Block Construction Examples

Referring now to Figures 9-13 and 16, a number of "speciality" blocks will be described. These alternative embodiment blocks may be modifications of the structure of the modular, composite block 50 discussed above. These specialty blocks can be full height or half height, depending on the look desired. In all cases, block construction and wall assembly may be similar to that described above for the modular block 50. However, the shape of the walls 52 and 54, and placement of the connective structure 56, may be modified as discussed below.

Figure 9 is a top view of a typical corner block 160 of the present invention modular block 50. This corner block 160 is designed to present a corner that preserves a stylistic surface. The corner block 160 of the present embodiment may have an angled outer wall 162, and a short inner wall 164.

The walls 162 and 164 are connected by two connective struts 166, 168. A connector leg 170 may also be provided. The connector leg 170 may extend from the outer wall 162 as shown. The connector leg 170 may have an end fixture 171 used to connect to an extension 58a from an end connective strut 58 of a standard modular block 50 as part of the overall wall as shown in Figure 10. The shape of the outer wall 162 may be a right angle or may be molded as a gentle smooth curve. Furthermore, decorative structures may be incorporated into the corner block, such as a pattern suggesting a column.

Figure 10 shows how the corner connector 160 is connected to a standard modular block 50. The placement of these specialty blocks alternates the side on which the corner connector 160 is placed with each layer of blocks laid. The mortar 120 may be placed as shown.

Figures 11-13 and 16 show top and side views of various alternative embodiments of the present invention modular block. Each of the various modular blocks illustrate the versatility of the present invention, but these are not meant to limit the scope of the present invention to modular blocks illustrated here. Each of the various modular blocks will be discussed in turn below and could further be modified with inserted panels, tension members, rebar, concrete filling, insulation filling, etc., as described above.

Figure 11 shows a top view of another alternative embodiment of the modular block 50 of the present invention. This modular block 180 further comprises two separate connective struts 182a and 182b. Each connective strut may further comprise a wall connector fitting 183a and 183b. The fitting 183a may be connected to wall 186 by fitting a first end over an extrusion 188 molded onto the interior surface of a wall 186. The fitting 183b may be fitted by spreading the fitting and inserting the fitting into

a pair of grooves190 molded into the interior surface of wall 184. Each of the wall connector fittings 183a and 183b exerts primarily a compressive force upon the adjacent wall material it contacts, securely binding the connective strut 182a, 182b to the inner and outer walls. As one reasonably skilled in the art will appreciate, the wall connector fittings on opposite strut ends could both be the same instead of different. Furthermore, in alternative embodiments the composite block 180 may incorporate a center connective structure to serve as a handle (not shown) for easy lifting and transportation of the block 180 and also to provide additional connective structural support.

Figures 12 and 13 show top and end views of a modular block 212 of an alternative design. In Figures 12 and 13, the connective structure 210 uses a single center connective strut 218 that extends between two parallel wall runners 219a, 219b, each positioned adjacent and parallel to one of the inner and outer walls. This embodiment of the block may further comprise an outer wall 214, an inner wall 216, a first pair of wall connectors 215a, 215b formed at opposite ends of wall runner 219a, and a second pair of wall connectors 216a, 216b formed at opposite ends of wall runner 219b. (While each of the wall connectors is shown as similar to those in Figures 1-5, the legs that are similar to first leg 92a, a second leg 92b as seen in Figure 4 might also be formed by rotation apart to make a more T-shaped insert, with a corresponding profile for a good friction fit in the corresponding wall groove.) The connective strut 218 and the pair of wall runners 219a, 219b fixedly secure the block walls 214 and 216 together. To provide additional rigidity to the runners 219a, 219b they may be formed with a honeycomb pattern or reinforcing ribs 223, shown schematically in Figure 12.

In this embodiment, the separate center partitioning panel (see 130 in Figure 1) is changed to an insulating panel member 222. This may be a preformed block 222 (of plastic foam or a similar

material), that fits around and on the connective strut 218 immediately adjacent one of the wall runners (219b in Figure 12) and fills some portion of the cavity formed by the inner and outer walls 214 and 216. This preformed block 222 may provide not only insulation properties, but could be rigid enough to provide some structural properties as well, once it is affixed on the connective structure 218. The preformed insulation block 222 may be formed with a groove 220 that form-fits to the connective structure 210 as shown. The block 222 may also be formed of a size so that it spans across the between-wall cavity, i.e., its edges are substantially in alignment with the edges of the inner and outer walls 214 and 216. In addition, to limit air infiltration though the insulation layer of a completed wall, one or more compressible foam strips 224 or extension ribs may be added to or formed with the insulation block 222 to prevent or limit gaps between insulation blocks of vertically or horizontally adjacent composite blocks. In one embodiment, the insulation block 222 may slide into the connective structure 218 by insertion on the connective strut 218 and rotation into a position supported by it, after the connective structure is inserted to join the inner and outer walls 214 and 216.

A benefit of this embodiment is that connective strut 218 can be made so that its vertical height is at least one sixth and preferably about one-fourth to one third of the vertical height of one of the inner and outer walls 214, 216. (That is, the vertical height might be two and a half inches for a block with nominal vertical height of eight inches.) With the panel member 222 made as a separate component and having a thickness about the same as the vertical height of the connective strut 218, the two unassembled components take up limited volume. However, the two assembled components can provide a rigid block unit with a significant insulating layer.

A further embodiment is illustrated in Figure 16. This figure shows a modular block 220 with a solid masonry jamb end 222. Connective struts 224 provide structural strength between the inner and outer walls. The utility of such a construction is well known to those reasonably skilled in the art for ending a wall structure. The interior of this block may incorporate panel members fitted on the connective struts 224 and may also be filled with concrete, insulation, wires, rebar, etc.

D. Further Alternative Embodiments of the Composite Building Blocks

It will be readily apparent to those skilled in the art that innumerable variations, modification, applications, and extensions of these embodiments and principles can be made without departing form the principles and spirit of the invention. Accordingly, it is intended that the scope of the invention be only limited as necessitated by the accompanying claims.